Event plane determination in the STAR TPC

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The anisotropy in the azimuthal distribution of particles is often characterized by v_1, v_2 and called directed and elliptic flow respectively. This anisotropy, especially v_2, plays an important role in high energy nuclear collisions and is expected to be even more important at RHIC energies. The parameters v_1 and v_2 are determined from fitting the azimuthal distribution of particles with a Fourier expansion[1],

$$E\frac{\mathrm{d}^3N}{\mathrm{d}^3p} = \frac{1}{2\pi}\frac{\mathrm{d}^2N}{p_t\mathrm{d}p_t\mathrm{d}y}\left(1+\sum_{n=1}^{\infty}2v_n\cos[n(\phi-\Psi_r)]\right)$$

where Ψ_r is the "true" reaction plane angle.

To characterize the anisotropy, the reaction plane is determined using the anisotropy in the azimuthal distribution of particles itself. This estimated reaction plane angle is called Ψ_n. The magnitude of the anisotropy and the finite number of particles available to determine this reaction plane leads to a finite resolution. Therefore, the measured v_n^{obs} parameters with respect to the event plane have to be corrected for this event plane resolution

$$v_n = \frac{v_n^{\mathrm{obs}}}{<\cos[n(\Psi_n-\Psi_r)]>} \; .$$

However, the "true" reaction plane is not known experimentally. Following Ref.[2], if one constructs the event plane from two random subevents one can relate the resolution of the subevents to the full event plane resolution,

$$<\cos[\mathrm{n}(\Psi_\mathrm{n}-\Psi_\mathrm{r})]> = \mathrm{C}\times\sqrt{<\cos[\mathrm{n}(\Psi_\mathrm{n}^\mathrm{a}-\Psi_\mathrm{n}^\mathrm{b})]>},$$

where C is a correction for the difference in subevent multiplicity compared to the full event[2] and Ψ_n^a, Ψ_n^b are the angles of the event planes determined in subevents.

To calculate how well the reaction plane can be determined in STAR using the TPC, which covers the rapidity region of -1.5 $\leq y \leq$ 1.5, RQMD v2.4 model predictions for Au+Au at $\sqrt{s}$ = 200 AGeV have been used. For these predictions 40 000 events have been used. In fig. 1a

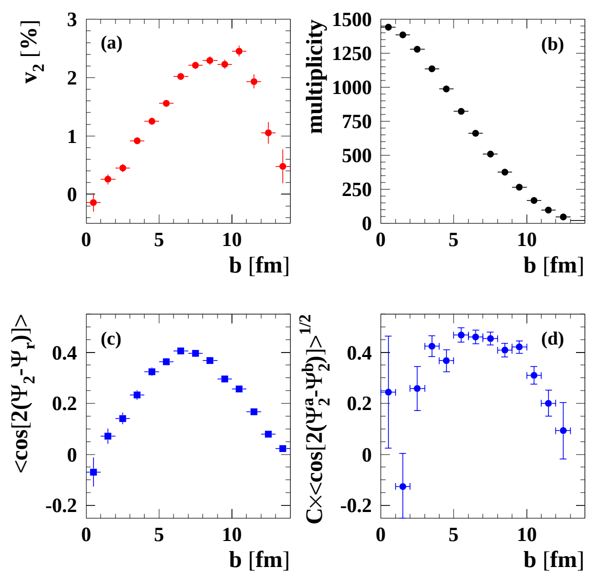

Figure 1: *RQMD v2.4 prediction using $\pi^+ + \pi^-$ within -1.5 $\leq y \leq$ 1.5. For description see text.*

the integrated magnitude of v_2 for pions versus the impact parameter b is shown. Fig. 1b shows the corresponding multiplicity as a function of b. These quantities lead to a resolution for v_2 calculated using the "real" reaction plane as shown in fig. 1c. The resolution for v_2 which can be obtained in the STAR TPC using subevents is shown in fig. 1d. This figure clearly shows, assuming the RQMD predictions (multiplicity distribution, magnitude v_2) are correct, that v_2 already can be determined in the STAR TPC by measuring 40 000 events. This should be available in day one running.

Footnotes and References

[1] S. Voloshin and Y. Zhang, Z. Phys. C **70**, 665 (1996).

[2] A.M. Poskanzer and S.A. Voloshin, Phys. Rev. C **58**, 1671 (1998).